TR16-RS485-25A

Voltage and direct current multi-channel analyser

1. DESCRIPTION OF THE DEVICE

The **TR16-RS485** is a measurement device for up to sixteen direct current channels and a voltage channel of up to 1000 V of direct voltage. The measurement of the current is done by means of sixteen Hall effect transformers (transformer for measuring direct current), with 25 A primary.

The device has 2 RS-485 communications ports. The first of these is used to connect and transmit the information to the master by means of the Modbus/RTU protocol. The second communications port, allows for setting up a multi-master type of communications typology (see section 4.5. Connection diagram of the RS-485 slave and sub-slave connection bus), given the multitude of applications that can be comprised by a large number of **TR16-RS485** analysers. The communications parameters can be configured by using the selectors located on the front panel of the device.

Moreover, this device is equipped with 3 (logical) digital inputs, for detecting the status of digital signals, coming from the device's surroundings and the information of which is also available via RS-485 communication. Apart from the digital inputs, the device is equipped with an analogue input with a 0...20 mA range and an input for a configurable Pt100 or Pt1000 probe.

2. PRELIMINARY CONSIDERATIONS

2.1 Verifications on receiving

Upon receiving the instrument verify the compliance of the following points:

- The device corresponds to the specifications of your order.
- Verify that the device has not been damaged in transit

2.2 Safety precautions

For the safe use of the device, it is essential that the people who install or handle it follow the usual safety measures, as well as the warnings documented in the said instructions manual.

The **TR16-RS485** device has specifically been designed to be installed inside an electric or enclosed cabinet, fastened to a DIN rail. Under no circumstances may the device be installed or integrated into a place where it is in direct contact with people. The **TR16-RS485** is fitted with a blinking red LED light (CPU), which warns that it is running, and therefore warns of the presence of voltage and current in the electronic circuit. Even though the LED light is not on, this does not free the user of verifying that the device is disconnected from all power sources.

3. INSTALLATION AND START-UP

This manual contains information and warnings that the user must adhere to in order to guarantee the safe operation of the device, and maintain it in a good state with regards to safety. In its usual operation it should not be used until it has been mounted in its final location in the electric cabinet.

IMPORTANT!

If the equipment is used in a manner not specified by the manufacturer,
the device's protection may be compromised.

When it is probable that the device may have lost its safety protection (for example, if visible damage can be seen), the device must be disconnected from the power supply. In this case, contact the qualified technical service or otherwise contact our Technical assistance Service (see section 7. TECHNICAL ASSISTANCE SERVICE).

3.1 Equipment installation

The installation of the device is of the DIN rail type; it has a surface of 9 DIN modules (160 mm), and a height of 58 mm. All the connections remain accommodated inside the electric cabinet.

Take into account that with the equipment connected, the terminals and the opening of the covers or the elimination of elements, may give access to parts that it is hazardous to touch. The equipment must not be used or powered up until its installation has been fully completed.

IMPORTANT!

DC power supply of TR16 must be protected by fuses, circuit-breaker or any other devices providing overcurrent protection. This devices must be set according to the DC installation power.

The equipment must be connected to a fuse-protected power circuit, in accordance with its power supply range and consumption. In turn, the power supply circuit must be fitted with a circuit breaker switch or an equivalent device, in order to be able to disconnect the equipment from the power supply grid. The power supply circuit must be connected using a cable with a minimum section of 1 mm².

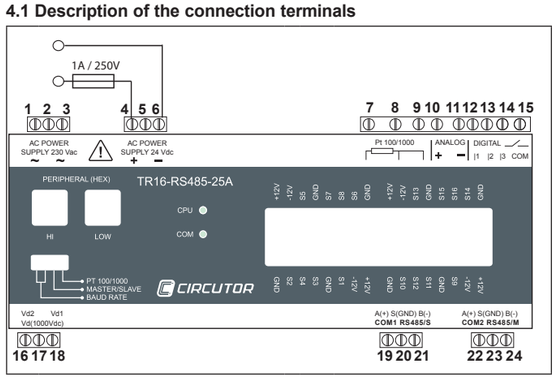
3.2 Power supply of the equipment

The device has two auxiliary power supply inputs; one for alternating current and the other for direct current. Under no circumstances may the user connect both power supply inputs simultaneously.

Power Supply	AC	DC
Nominal voltage	230 V~	24 V ⎓
Power supply tolerance	± 20%	± 10%
Frequency	50 Hz	-
Equipment consumption without transformers	2 VA	2 W
Equipment consumption with 16 sensors (without load)	14 VA	8 W
Equipment consumption with 16 sensors (with current load)	24 VA	14 W
In-rush current	3.5 A (3 ms)	15 A (1 ms)
Operating conditions		
Operating temperature	-10 ... 65 ºC	
Relative humidity	5...95 RH without condensation	
Maximum operating height	2,000 metres	
Protection	IP20	
Accuracy		
Voltage measurement margin	30 ... 1000V	Current measurement margin (FS: 3.9V) 10 ... 100 %
Voltage measurement Error	1% FS	Current measurement Error ± 0.5 % FS
Resolution Error	± 0.075 % I_n	Offset Error 0.075 % I_n
Temperature input accuracy		
Pt100 / Pt1000 temperature probe	± 3 ºC	
Analogue input accuracy		
Input accuracy 0...20 mA	± 0.5 %	
Input impedance	165 Ω	
Resolution in dots	1024 dots	
Converter resolution	10 bits	
Digital inputs		
Quantity 3	Impedance	12 MΩ
Safety		
Category III – 300 V~ Voltage measurement: Category III - 1000V ⎓ Overcurrent internaly protected by high impedance Double-insulated electric shock protection class II		

4. CONNECTIONS

4.1 Description of the connection terminals



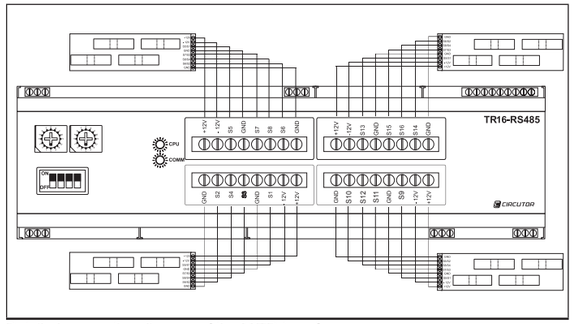
	Description		Description
1	Power supply 230 V ~	13	Digital input 2
2	Not used	14	Digital input 3
3	Power supply 230 V ~	15	Common digital inputs
4	Power supply 24 V ⎓ (positive)	16	Direct voltage (positive)
5	Not used	17	Not used
6	Power supply 24 V ⎓ (negative)	18	Direct voltage (negative)
7	Pt100 / Pt1000 probe input	19	Slave RS485 port (A – positive)
8	Pt100 / Pt1000 probe input	20	Slave RS485 port (S – GND)
9	Pt100 / Pt1000 probe input	21	Slave RS485 port (B – negative)
10	Analogue input 0...20 mA (positive)	22	Master RS485 port (A – positive)
11	Analogue input 0...20 mA (negative)	23	Master RS485 port (S – GND)
12	Digital input 1	24	Master RS485 port (B – negative)

IMPORTANT!

If a transformer not specified by the manufacturer is connected, or it is connected to a different primary current than that specified in this manual, the current measurement will be incorrect and the device's protection may be compromised.
If no probe is connected to the device, you must make a bridge between the three terminals meant for the probe. (7, 8, 9).

4.2 Connection diagram of the current transformers

The **TR16-RS485** is a device designed to measure up to 16 direct current lines simultaneously. The device is equipped with 16 inputs for Hall effect transformers, with which one can measure up to 25 A per direct current channel.



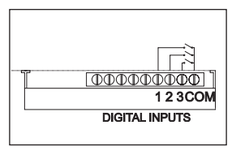
Detailed connection diagram of the M/TR transformers

For connecting the M/TR-25A to the **TR16-RS485,** device, the use of a screened cable is recommended, the mesh of which must solely be connected to the GND connector on the device.

Optionally, up to a maximum of four M/TR-25Ax4 modules (16 channels) can be connected to the **TR16-RS485** device. After initialising, the equipment performs a scan of all the inputs of the transformer modules, disabling the unused, and consequently not physically connected inputs, by software. In the event that a new four transformer M/TR module is subsequently connected, the user must reset the device's power supply, for the four new current measurement transformers to be recognised.

4.3 Connection diagram of the digital inputs

The **TR16-RS485** device has three voltage-free inputs and a voltage of 24 V DC on the common one for detecting the logical status of the external pickups. On a real-time basis it detects the status of the inputs (open contact or closed contact), and transmits this information through the RS-485 communications bus.



The use and cabling of the said inputs is entirely optional and its implementation does not affect the operation of the rest of the assembly.

4.4 Connection diagram of the conventional RS-485 communications bus

The **TR16-RS485** has an RS-485 communications port for real-time connection with a master PLC or SCADA industrial control type communications system. The communication must be made using a twisted-pair mesh-screened communications cable, with a three-core minimum. Between the master system and the last peripheral, the systems allows for a maximum distance of 1,200 metres. A maximum of 32 parallel-connected peripherals may be connected to the communication bus, for each port used.

In any event, star-type installations must be avoided, as the communications bus output of a peripheral must be chained to the input of the next and successive ones.

For installing these devices, it should be noted that there is no prior need of any type of end-of-line resistor. SEE DIAGRAM A

4.5 Connection diagram of the RS-485 slave and sub-slave communications bus

The **TR16-RS485** has a second communications bus, which has the purpose of being able to communicate with other **TR16-RS485**s in a parallel manner (sub-slave devices).

The nodes connected to the main bus, can simultaneously be connected to 15 new devices. Therefore, at the main bus level, a maximum of 32 devices can be installed, plus 15 sub-slave devices per installed node.

This communications typology results in the installation of 512 nodes on a single communications network, without this fact penalising the *pooling* time of the main communications bus.
The leading device connected to the main network, registers all the memory addresses of the sub-slave devices connected to it, thus reducing the number of nodes to be queried along the communications bus by the communications master, therefore reducing the *pooling* time.
The typology and the connections setup is described in DIAGRAM B

5. CONFIGURATION

In that relating to the measurement of voltage or direct current, the device does not require any special type of configuration, as the internal adjustment configuration ranges come set from the factory.

5.1 Communications

The implemented communications protocol is of the MODBUS/RTU® type.

As shown in the connection diagrams, the **TR16-RS485** peripheral is connected to a control system by means of the RS-485 bus. For this purpose, each of the devices must be assigned a node number to identify them within the communications bus.

The front panel of the device is fitted with rotary switches and MINI-DIP switches that allow the user to adjust the parameters of the different communications settings. To integrate the device in the bus, only the node or peripheral number and the transmission speed of the RS-485 bus need to be set, which must naturally be the same as that of the communications master.

By default, the communication is set to 1 stop bit, Parity No and 8 bits in length (8/N/1).

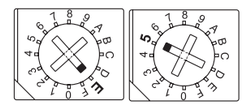
5.2 Setting the peripheral number.

The two rotary switches on the front panel of the device, are used to set the peripheral number (node). As the device communicates in Modbus/RTU protocol, the peripheral or station number may vary in the range 1 to 255 (FF in hexadecimal).

The node number is set in hexadecimal format; under no circumstances may this be set in decimal format. See several examples of the conversion of decimal to hexadecimal:

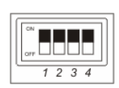
Decimal Node	Hexadecimal Node	Decimal Node	Hexadecimal Node
10	0A	80	50
15	0F	150	96
25	19	180	B4
50	32	200	C8
65	41	255	FF

For the hexadecimal node number, the first digit is set with the left-hand switch and the second with the right-hand switch. After the device number has been set, it is not necessary to reset the device.



5.3 Setting the transmission speed

The **TR16-RS485** has a module with four (MINI-DIP) switches, which allow the transmission speed to be set using switches 1 and 2. See the following table:



Transmission speed	Switch 1	Switch 2
9,600 / 8 / N / 1	OFF	OFF
19,200 / 8 / N / 1	OFF	ON
38,400 / 8 / N / 1	ON	OFF

When a change is made to the transmission speed, it is not necessary to reset the device. Nor when the node (peripheral) number is changed.

5.4 Setting slave and sub-slave devices

Using switch number 3, the user can set the type of communications typology. The device may be set as a conventional slave of a communications network, or otherwise as a sub-slave within a *multislave* network.

5.4.1 Slave devices

In DIAGRAM A, the communications bus is of a conventional communications typology. In this type of typology the peripherals may be numbered from 1 to 255 (from 01 to FF in hexadecimal).

Position of Switch 3 Diagram A	OFF	The numbering of the node numbers may vary between 1 and 255 (from 01 to FF in hexadecimal).

5.4.2 Sub-slave devices

For communications systems with slaves and sub-slaves (DIAGRAM B. Connection diagram of the RS-485 slave and sub-slave communications bus), the communications of the devices marked as sub-slave ($A1_2$, $A2_2$,.., $A32_2$ ... $A1_{16}$, $A2_{16}$,.., $A32_{16}$) must have different settings and a node numbering system in order.

The slave nodes (A_1, A_2 ... A_{32}), the same as specified in the previous section, can be numbered from peripheral 1 to 255 (from 01 to FF in hexadecimal). On the other hand, the sub-slave nodes of each of the communications buses, must be numbered from 2 to 16 (from 02 to 10 in hexadecimal), and consecutively in each of their related buses. The slave devices cannot detect the presence of sub-slave devices with node numbers above 16 (10 in hexadecimal).

Equipment:	Switch 3	Decimal Node	
A1	ON	01	The numbering of the node numbers may vary between 1 and 255 (from 01 to FF in hexadecimal). Under no circumstances may they be duplicated, and they need not be assigned in a logical or sequential order.
$A1_2$	OFF	02	The numbering of the node numbers may vary between 2 and 16 (from 02 to 10 in hexadecimal) and must be sequential, without leaving any node numbers unassigned.
...	OFF	--	
$A1_{16}$	OFF	16	

IMPORTANT!

If new sub-slaves are added, the slave device must be reset (leading bus: A_1, A_2 ... A_{32}). For example, if device $A2_3$ is added, device A_2 must be reset.

This operation is required so that the leading element performs a scan of the entire communications bus an implements all the information from its sub-slave devices in its memory map.

5.5 Analogue input and temperature probe

The **TR16-RS485** is equipped with an analogue input to connect a probe or an industrial sensor. The analogue input behaves in a linear manner, delivering by transmission the analogue measurement in resolution dots (from 0 to 1024 dots). The communications master is responsible for converting the said dots to physical values that the user can understand.

Moreover, the equipment has an input for the connection of a Pt100 or Pt1000 type temperature probe. To connect one or the other type of probe (Pt100 or Pt1000), it must be selected by using the fourth switch located on the front panel. Once the switch has been set, the equipment sends the temperature value in degrees centigrade by communication.

Temperature probe	Switch 4
Pt100	ON
Pt1000	OFF

5.6 Modbus protocol

The **TR16-RS485** peripheral uses the MODBUS© protocol. Within the MODBUS© protocol, the RTU (Remote Terminal Unit) mode is used; every 8-bits per byte in a message contains two 4-bit hexadecimal characters.

The format for each byte in RTU mode is:

Code	8 binary bits, hexadecimal 0-9, A-F 2 hexadecimal characters contained in each 8-bit field of the message.
Bits per byte	8 data bits
Check-Error field	CRC (Cyclical Redundancy Check) type

Implemented Modbus functions:

Functions 03 and 04	Function used for reading the parameters measured by the **TR16-RS485**. All the electric parameters are 16 bit words, so that to request each parameter one Word (2 bytes – XX) is needed.

5.6.1 Modbus/RTU® memory map

This table shows the Modbus addresses of the conventional slave device. In the successive tables (from module 2 on), the memory addresses are displayed for the sub-slave devices, if these are connected.

Description	Abbreviation	Symbol	Address	Unit
Input current 1	M1-MLC1	*I 1*	0000	A x 100
Input current 2	M1-MLC2	*I 2*	0001	A x 100
Input current 3	M1-MLC3	*I 3*	0002	A x 100
Input current 4	M1-MLC4	*I 4*	0003	A x 100
Input current 5	M1-MLC5	*I 5*	0004	A x 100
Input current 6	M1-MLC6	*I 6*	0005	A x 100
Input current 7	M1-MLC7	*I 7*	0006	A x 100
Input current 8	M1-MLC8	*I 8*	0007	A x 100
Input current 9	M1-MLC9	*I 9*	0008	A x 100
Input current 10	M1-MLC10	*I 10*	0009	A x 100
Input current 11	M1-MLC11	*I 11*	000A	A x 100
Input current 12	M1-MLC12	*I 12*	000B	A x 100
Input current 13	M1-MLC13	*I 13*	000C	A x 100
Input current 14	M1-MLC14	*I 14*	000D	A x 100
Input current 15	M1-MLC15	*I 15*	000E	A x 100
Input current 16	M1-MLC16	*I 16*	000F	A x 100
Differential Voltage	M1-VDG	*Vd*	0010	V x 10
Pt100/Pt1000 temperature	M1-TEMP	Pt100/Pt1000	0011	ºC
Analogue input	M1-ANAL		0012	Dots
Digital inputs	M1-DIG		0013	0 / 1
Not used			0014	
Peripheral number	M1-PERIPH		0015	

In the successive tables (from sub-slave 2 on), the initial addresses of the modules are shown, taking into account that they all have the same distribution available to the leading bus device.

Module	Addresses
2	0016 to 002B
3	002C to 0041
4	0042 to 0057
5	0058 to 006D
6	006E to 0083
7	0084 to 0099
8	009A to 00AF
9	00B0 to 00C5

Module	Addresses
10	00C6 to 00DB
11	00DC to 00F1
12	00F2 to 0107
13	0108 to 011D
14	011E to 0133
15	0134 to 0149
16	014A to 015F

Examples of the memory addresses of some of the sub-slave devices, if these are connected.

Module 2	Address	UDS
M2-MLC1	0016	A x 100
M2-MLC2	0017	A x 100
M2-MLC3	0018	A x 100
M2-MLC4	0019	A x 100
M2-MLC5	001A	A x 100
M2-MLC6	001B	A x 100
M2-MLC7	001C	A x 100
M2-MLC8	001D	A x 100
M2-MLC9	001E	A x 100
M2-MLC10	001F	A x 100
M2-MLC11	0020	A x 100
M2-MLC12	0021	A x 100
M2-MLC13	0022	A x 100
M2-MLC14	0023	A x 100
M2-MLC15	0024	A x 100
M2-MLC16	0025	A x 100
M2-VDG	0026	V x 10
M2-TEMP	0027	ºC
M2-ANAL	0028	Dots
M2-DIG	0029	0 / 1
Not used	002A	
M2-PERIPH	002B	

Module 3	Address	UDS
M3-MLC1	002C	A x 100
M3-MLC2	002D	A x 100
M3-MLC3	002E	A x 100
M3-MLC4	002F	A x 100
M3-MLC5	0030	A x 100
M3-MLC6	0031	A x 100
M3-MLC7	0032	A x 100
M3-MLC8	0033	A x 100
M3-MLC9	0034	A x 100
M3-MLC10	0035	A x 100
M3-MLC11	0036	A x 100
M3-MLC12	0037	A x 100
M3-MLC13	0038	A x 100
M3-MLC14	0039	A x 100
M3-MLC15	003A	A x 100
M3-MLC16	003B	A x 100
M3-VDG	003C	V x 10
M3-TEMP	003D	ºC
M3-ANAL	003E	Dots
M3-DIG	003F	0 / 1
	0040	
M3-PERIPH	0041	

5.6.2 Reading of the status of the digital inputs (DIG)

The DIG variable, like the rest of the electric variables, is a record (1 word = 2 bytes), in other words, in hexadecimal it would be 0xFFFF. The inputs go from 1 to 3 and these represent the 3 lower weight bytes:

HIGHEST WEIGHT BYTES								LOWEST WEIGHT BYTES							
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	0	0	0	0	0	I3	I2	I1

To know the Modbus memory addresses, refer to section 05.06.01 Memory map. The value of each input determines if it is activated (1) or deactivated (0).
Example 1 (in master device):

TX	NP 0400090001 CRC	
Input activated	3	
By communication	INP=0x0004	Hexadecimal
	0000000000000100	Binary

Example 2 (in master device):

TX	NP 0400090001 CRC	
Input activated	2 and 3	
By communication	INP=0x0006	Hexadecimal
	0000000000000110	Binary

5.6.3 Reading the peripheral number

The PERIPH variable, like the rest of the electric variables, is a record (1 word = 2 bytes), in other words, in hexadecimal it would be 0xFFFF. This record refers to the peripheral number associated by using the front panel on the equipment, for each of the slave and sub-slave devices.

5.6.4 Number and listing of sub-slave devices connected

Number of sub-slave devices: There is a Modbus record (0834), which indicates the number of sub-slave devices connected to the communications master (see in DIAGRAM B, devices, A_2 ... A_{16}). Said variable solely returns the numeric value in hexadecimal, reporting the number of nodes connected to the device through the master communications port (if it is used).
Example 1:

TX	NP 0408340008 CRC
RX	NP 0402 0006 CRC

Number of slaves	6	
By communication	RX = 0x0006	Hexadecimal
Decimal conversion	6	Decimal

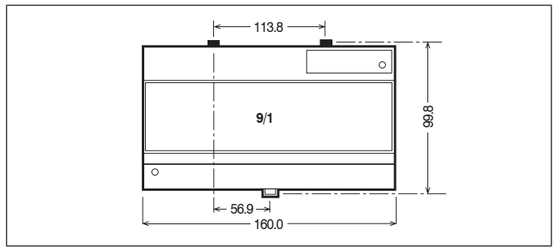
Listing of sub-slave devices: As opposed to the number, the listing of sub-slave elements connected to a master device, reports one by one, the peripheral numbers connected to the said master device (record 07D0).

Example 1:

TX	NP 0407D0000F CRC
RX	NP 0420 02 03 04 05 06 00 00 00 00 00 00 00 00 00 00 00 CRC

Listing of slaves	02, 03, 04, 05, 06	Hexadecimal
Decimal conversion	02, 03, 04, 05, 06	Decimal

6. DIMENSIONS



7. TECHNICAL ASSISTANCE SERVICE

If you have any doubts about the operation of the equipment or any malfunction, please contact the technical assistance service at **CIRCUTOR SA**

CIRCUTOR, SA - Technical Assistance Service
Vial Sant Jordi, s/n - 08232 Viladecavalls (Barcelona) SPAIN
Tel.: 902 449 459 (Spain) - +34 93 745 29 00
email: sat@circutor.es

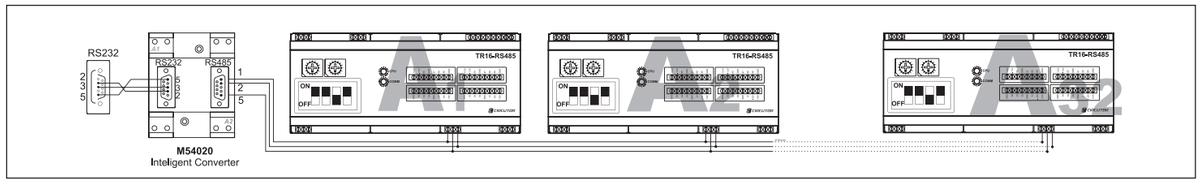


DIAGRAM A - Connection diagram of the RS-485 communications bus with slave devices (conventional bus)

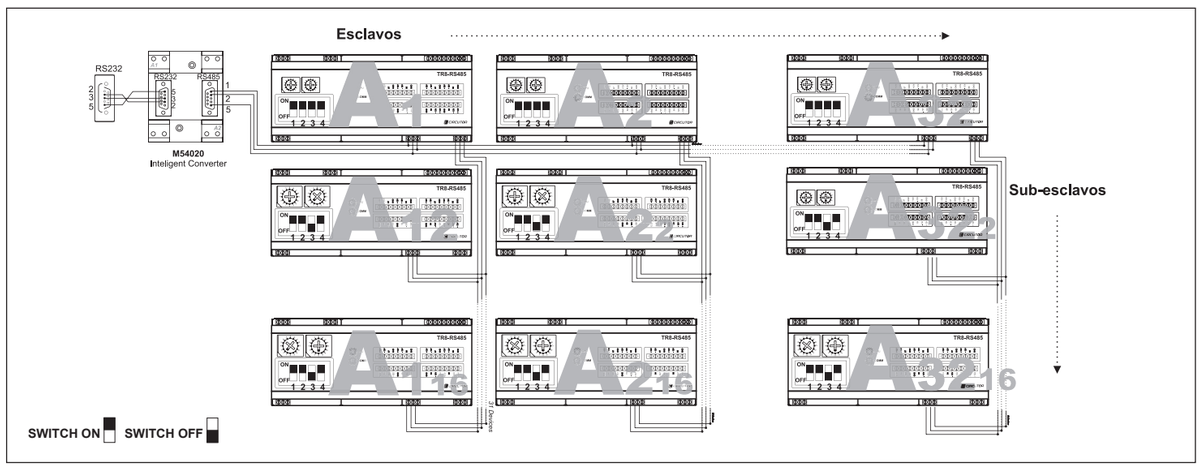


DIAGRAM B - Connection diagram of the RS-485 communications bus with slave and sub-slave devices